Course Name: Architectural Approaches to Decarbonization of Buildings

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Lecture 3

Daylighting- Case studies 2

Hello everyone. So, in this series of lectures we have been focusing on daylighting because the energy required for lighting a building increases its operational energy and therefore increases the operational carbon. So, today we will look at two case studies which have been designed specifically to ensure that the building is well lit with natural daylight and that has resulted in substantial reduction in energy consumption and cost. The first is the PEDA building. The PEDA building is the Punjab Energy Development Agency. This building has been designed by Le Corbusier This building is dome shaped and it is a concrete structure on the southwestern facade.

It has horizontal and vertical fins which are very interesting, which have glass. placed in between the spaces to enable natural light but with reduced glare. Now this allows indirect light to enter the building in the summer and direct light to enter the building in the winter. This building also has an atrium which is covered by a very lightweight roofing.

It's a shell roofing, which is about 10 centimeter high density. And it has the EPS sandwiched between high grade FRP sheets, fiber reinforced plastic sheets and reinforced with steel. specifically angled to allow sun in winters and block the sun in the summer. So, these are the interesting domes I was talking to you about which allows the winter sun, but cuts the summer radiation Intense radiation light. So the Punjab Energy Development Agency at Chandigarh is a state nodal agency and it is responsible for development of new and renewable energy and non-conventional energy in the state of Punjab.

And hence the building had the onus to prove itself to be a energy efficient building. The building has a three-dimensional form which responds to solar geometry. That is, it minimizes solar heat gain during the very dry and extremely hot periods. But there is also a severely cold period and during that time it maximizes the solar heat gain inside the building. Now, overlapping floors at different levels in space floating in a large volume

of air with interpenetrating large vertical cutouts which are enclosed within the overall building envelope.

These are integrated with light wells and solar activated naturally ventilating domical structures. Now, if you see on the south or rather on the southwestern side, the dome shaped concrete, these are the dome shaped concrete structures. They have horizontal and vertical intersecting fins. So, they have a horizontal and vertical intersecting fins which have glass fixed in the voids. So this is all glass which allows sunlight but with reduced glare.

These allow indirect light to enter the building during summer. But in the winters, it's direct sunshine. This atrium is covered by a lightweight shell roofing of 10 centimeters thick. If you see , there are other features which we could quickly look into, which are energy efficient features. This building also has a wind tower.

The building also has provision for north lighting and it has photovoltaic cells along with the light weight. There is also solar chimney and wind tower. So you can see that this is the horizontal and vertical ribs that I had been talking about with the glazing here giving diffused lighting inside. And here you have the north lighting. North lighting is specifically designed to give diffused light and also have solar panels which generates enough electricity to support whatever extra electricity is required for lighting inside.

Now the envelope of the building actually accentuates the outside ambient conditions And the large volume of air is naturally conditioned by controlling solar axis as a response to the extremes of summer which is very hot and winter which is very cold. You can see the diffused light. due to these very different and interesting features inside the building. And you can also see how the light enters and it is diffused largely because of the large overhangs as well as the nature of the glazing. So, here you can see the large volume of air which is cooled during hot period with a wind tower.

This is integrated into the building design and during the cold period this volume of air is heated by solar penetration through the roof glazing and it generates a convective loop. and here you can see that there are these vertical fins and horizontal here you can see the system of horizontal and vertical fin which are not only allows sufficient daylight But it also aids in keeping the building warm during winter and does not increase the heat load during summer by virtue of its orientation. There is a solar chimney. So, this conical slab supports the solar chimney and which has a air outlet keeping the channels. And this wind tower along with solar chimney is centrally placed.

And it's one of its salient features of this building which results in solar passive design

being highlighted. And in this context, this building is a green building. So, instead of designing indirect plus direct evaporative cooling system the there is another system which is used in the building which we will be discussing in another course, but I will give a small sneak peek into the word it is called PDEC passive down draft evaporative cooling system which can be used to make the building very favorable to work because it increases the humidity during very dry conditions too. So, the quality of the air also becomes very favorable. So, this building has multiple passive features.

some of the features are simple passive techniques and some of the features are advanced passive techniques. So, this building is a combination of both making it a green building because it looks at not only temperature but natural lighting as an important feature to this building. You can again see the shell roof in the atrium space which minimizes overheating and which gives in extensive diffused light inside the building along with the windows. You can see how the atrium makes the building very well lit. So, appropriate building design and orientation have made this building a very green building with respect to daylighting with other features also included making it a green building in terms of its thermal performance too.

So, this is the PEDA office complex which we saw which has light vaults. which enhances natural lighting. The next very interesting case study we will see is called as the Teri in Retreat in New Delhi. This is one of the first net zero buildings in the country This is one of the first net zero buildings in the country because when it was built it did not pay a single penny to the grid for its electricity consumption. Now this building is also very famous and popular for its natural lighting along with many other features that it has.

This is the south view of the building and you can see the south view receives maximum solar radiation during winters which is necessary in a composite climate like Delhi which has very severe winters. And this orientation ensured the winter sun to be brought in but it keeps out the summer sun and there is adequate daylight in the building. The south forms a hybrid convex surface facing the winter sun and the south view of the building shows how the hostel building has adequate daylighting. So you can see adequate daylighting through large glass panes along this south direction. Could also see large overhangs along this side and vertical fins.

So the south side openings are actually 1.5 meter wide and 1.5 meter high. This facilitate comparatively less daylight because of the large shading devices horizontal and vertical, but it is sufficient. Then you have the administrative block hostel.

And even here the overhang is about 550 millimeters overhang. And the vertical fins are

also about 550 millimeters. In some places the horizontal overhang is about even 1.2 meters. and the vertical fin is about 850 millimeters.

So, the large overhangs in the form of horizontal devices and vertical fins, horizontal sunshades or shading device and vertical fins ensure that the light that comes in is diffused because it is not from the harsh solar radiation. This is the main block or this is the three-dimensional block of the building. You can see that this building has ample amount of exposure to the outside, especially in its workplaces. This is one of the first rules one should have in mind if you want to tap natural daylights. When we look at the north facade, the north side openings were about 1500 millimeters, 1.

5 meters by 2.4 meter wide. And this 1.5 meters wide and 1.2 meter high windows, they facilitate optimum daylight. The deeper facade of the hostel building, it promotes diffused daylights to the rooms because of the very deep placement of windows due to very high overhangs. You can see even in this how the overhangs are very long.

When it comes to the east and the west facades, now these act more like thermal buffer zones. So, these facades become thermal buffer zones and they receive the maximum solar insulation. Therefore, the east and west facades are covered with jallies. So, along the east and west There are jalli work which protect the wall from direct solar radiation. And many of these service areas such as transformer rooms and staircases are placed on the east and west facade.

Now, the energy efficient lighting sustainable system do not stop at using only the windows but they also use renewable sources of energy from the sun. So, this energy so produced should be used efficiently. And also this building uses energy efficient lighting systems. CFLs is used which gives the same quality and amount of light as a normal incandescent bulb. So all these were things which were used way back even before 2001.

And at least all these are common now after CFL even LEDs have come. But they were way ahead of their times in the use of design which promoted natural daylight as well as energy efficient contraptions to ensure that the load on lighting from the grid is extremely less. Energy-efficient tube lights with electronic chokes have been used in areas which require artificial lighting, such as conference hall or computer room or recreational area. The conference rooms also enjoy glare-free daylight through strategically placed skylights. In the living rooms, strategically placed light points and specially designed swivels make it possible to use the light as a study table at a study table level as well as for bedside reading.

So, time-based controls which switch off lights at a preset time that also decreases the

load on electricity. Key tag system is installed in the rooms for energy conservation and solar lights have been used in the gardens in the outside areas. Therefore, Teri has followed the basic simple passive design strategies. And all the openings which allow natural light are designed based on the orientation on the facade. So, the openings on the north, south, east and west have been treated and handled differently to ensure natural daylight for most parts of the day and the year and the quality of light is also diffused and glare free.

We understand that it is up to the architect and the designer to ensure that at an early design stage the building is planned to be energy efficient and that makes the building green with less operational energy and less operational carbon emissions. With this we come to a close of this session. And in the next class, we will be having a recap, quick recap and a concluding session. Thank you.